R325IE Single Axis Controller / Driver
Encoder Version

CE

User Manual

And Commands Guide

Version 1.22

RMS Technologies
2533 N. Carson St. #4698, Carson City, NV 89706-0147

Thank you for purchasing the R325IE Single-Axis Controller/Driver. This product is warranted to be free of manufacturing defects for one (1) year from the date of purchase.

Technical Support
By Telephone: 408-919-0200
(Mon.-Fri., 8:00 a.m.-5:00 p.m.)
On the Web: www.linengineering.com
Our technical support group is glad to work with you in answering your questions. If you cannot find the solution to your particular application, or, if for any reason you need additional technical assistance, please call technical support at **408-919-0200**.

PLEASE READ BEFORE USING

Before you start, you must have a suitable step motor, a DC power supply suitable for the motor and a current resistor. The power supply voltage must be between 4 times and 20 times the motor's rated voltage.

DISCLAIMER

The information provided in this document is believed to be reliable. However, no responsibility is assumed for any possible inaccuracies or omissions. Specifications are subject to change without notice.

RMS Technologies reserves the right to make changes without further notice to any products herein to improve reliability, function, or design. RMS Technologies does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights, nor the rights of others

Note: This equipment has been tested and found to comply with the limits for a Class (*) digital device, pursuant to part 15 of the FCC Rules. These Limits are designed to provide reasonable protection against harmful interferences when the equipment is operated in its installation. This equipment generates, uses and can radiated radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. If this equipment does cause harmful interference the user will be required to correct the interference.

This Class (*) digital apparatus complies with Canadian ICES-003

Cet appareil numérique de la classe (*) est conforme à la norme NMB-003 du Canada

Special Symbols

Indicates a WARNING and that this information could prevent injury, loss of property, or even death (in extreme cases).

R325IE User Manual

Product: R325IE
Version: 1.21
Date: 06/07/2007

Version History		
Version	Date	Description of Changes
1.20	02/13/2006	New Formatting
1.21	06/07/2007	Added DV (Direction Velocity) command
1.22	08/23/2007	Added info on internal resistors and recommended resistors for opto-isolated inputs. Added Appendix B: PF Value

Table of Contents

1. FEATURES 5
   - Pole Damping Technology™ 5
   - Optically Isolated Inputs and Output 5
   - Encoder Feedback & Pinouts 6
2. ELECTRICAL SPECIFICATIONS 7
3. OPERATING SPECIFICATIONS 7
4. COMMUNICATION SPECIFICATIONS 7
5. MECHANICAL SPECIFICATIONS 8
6. PIN ASSIGNMENTS 9
7. CONNECTION SPECIFICATIONS 10
   - Connecting the Power 11
   - HyperTerminal Configuration 11
   - Setting the Current & Step Resolution 12
   - Saving the Configuration 12
   - Connecting the Motor 12
   - Configure the R325IE using the DIP Switch 13
     - DIP Switch Run Current Settings 13
     - DIP Switch Hold Current Settings 13
     - DIP Switch Step Resolution Settings 13
8. BASIC STEP AND DIRECTION OPERATION 14
9. COMMAND TABLES 15
   - Basic Configuration Commands 15
   - Axis Configuration Commands 15
   - General Operation Commands 15
   - 'E' Version Commands 16
10. COMMANDS 17
    - HOMING & POSITIONING 18
    - VELOCITY & ACCELERATION 18
    - SETTING CURRENT 20
    - STORAGE & RECALL 20
    - MICROSTEPPING 21
    - QUERY COMMANDS 21
    - ENCODER VERSION COMMANDS 22
11. RS485 Communication 23
12. Troubleshooting 25
13. Appendix A: Recommended Cables 26
14. Appendix B: PF Value 30

1. FEATURES

- Single Axis Driver for Bipolar step motors
- Operates from +15 to 48 VDC
- Phase currents from 0.3 to 3.0 Amp Peak

NOTE: Phase current of 2.7 Amp and above REQUIRES an additional heatsink, make sure the temperature of the bracket does not exceed 45° C.

- Hold current reduction capability with adjustable current and timeout settings
- Selectable Step Resolution from Full Step to 256x Microstepping
- Has three optically isolated control inputs and one optically isolated control output
- Software configurable by the temporary use of a plug-in USB module and text commands from HyperTerminal or any similar terminal emulation software.
- Configuration Parameters stored in non-volatile memory.
- Multiple module control through software assigned single character addresses
- Built-in control routines for trapezoidal position and velocity moves
- Absolute position can be tracked and reported in step resolution increments
- Static Encoder Feedback with a full set of parameters to configure a wide variety of motor and encoder combinations.
- Homing on Encoder Index
- Eight user presetable target positions
- Pole Damping Technology™ implemented within driver board

Dip switches and a RS485 interface are built-in to the R325 Controller. A USB connection can be used by using the USB485 Converter Card (sold separately).

Pole Damping Technology™

Pole Damping Technology™ (PDT) enhances step motor performance by dampening each full step in order to create a more accurate and smooth motion profile. Microstepping the step motor will optimize Pole Damping Technology™. PDT outputs the correct amount of run and hold currents to the motor, at the right time. Thus, it will overcome the step motor's natural tendency to want to forcefully pull towards the full step ON position.

Optically Isolated Inputs and Output

The default usage of the three optically isolated inputs is Step, Direction and Disable. The assignment of Disable is fixed; however the other two inputs can be assigned to other functions as part of software customization. For example one can be used for Go-Resume and the other for Stop-Quit.

The normal usage of the single optically isolated output is to indicate motion by sending a pulse every time a step is made.

R325IE Encoder Features:

Static encoder feedback with a full set of parameters to configure a wide variety of motor and encoder combinations.

Homing on encoder index

Eight user presetable target positions

Encoder Feedback

Each time the motor stops and times out ready to drop into the Hold current mode, a test is run to determine if the motor Absolute Position register and the Encoder Position register values correspond to the same position.

The motor Absolute Position register holds a measure of motor position in Steps at the current Step Resolution. To translate this value into an actual position requires the motor resolution to be also known.

The Encoder Position register holds a measure of encoder position in either Encoder Lines or Encoder Lines times two depending on the setting of the Encoder Mode parameter.

If the units used to measure motor position (Motor Fullsteps per Revolution multiplied by Step Resolution) has a higher resolution than the units used to measure the encoder position (Encoder Lines multiplied be Encoder Mode) then position error is measured in motor position units, otherwise the error is measured in encoder position units.

The count of the finer unit increments required to make up one of the coarser unit increments is calculated and stored as the Encoder Factor. This parameter is used each time an encoder to motor position check is made.

The user can enter a parameter value Error Limit that sets the maximum error allowed before corrective action is taken. This units for this parameter is the same as the Encoder Factor. The minimum value for this parameter is automatically set to match the Encoder Factor count. Generally the user would only modify this value for systems where the encoder and motor are not coaxial mounted and an allowance must be made for backlash.

Encoder Pinouts

P2 Configuration	
Pin No	**Function**
1	GND
2	Index
3	A
4	+5 V
5	B

2. ELECTRICAL SPECIFICATIONS

Supply Voltage: +15 to 48 VDC
Phase Current: 0.3 to 3.0 Amps Peak

NOTE: Phase current of 2.7 Amp and above REQUIRES an additional heatsink, make sure the temperature of the bracket does not exceed 45° C.

I/O Specifications
- 3x Optically Isolated Inputs (1 fixed)
- 1x Optically Isolated Output

Minimum Motor Impedance: 1.5 mH

Note: The drive may behave unpredictably if the motor you are using as an inductance less than 1.5 mH.

3. OPERATING SPECIFICATIONS

Maximum Step Frequency:	2.5 MHz
Operating Temperature:	Low end – 0° C High end – Dependent on case temperature, bracket temperature must not exceed 45° C

Automatic Motor Holding Current reduction available from 0.3 to 2.5 Amps

Logic Timing

Minimum Step Pulse Width	200 nanoseconds
Minimum Step Low Time	200 nanoseconds
Maximum Power-Down Recovery Time	20 milliseconds

4. COMMUNICATION SPECIFICATIONS

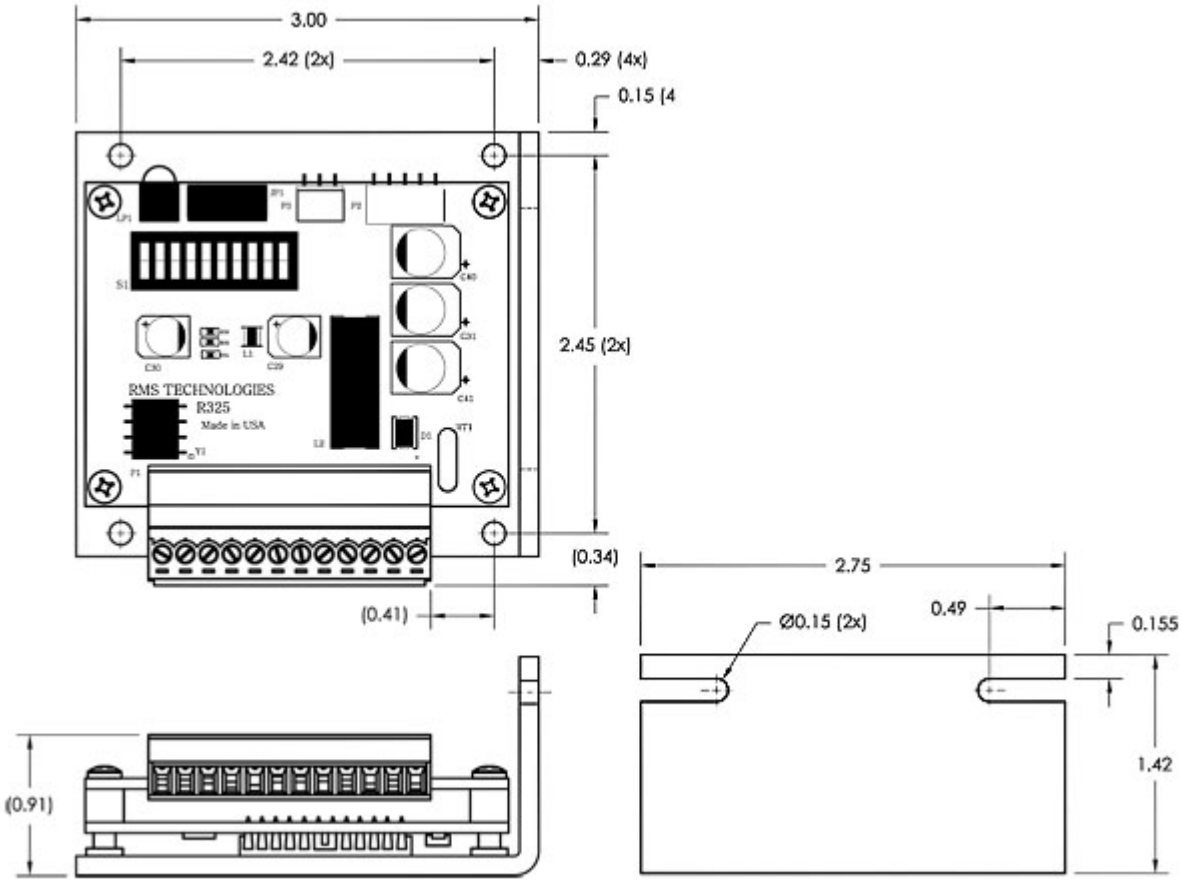
Address bytes in the RS485 commands allow multiple units (32 units max) to be controlled from a single host port.

Interface Type	RS485
Baud Rate	57600 bits per second (bps)
# Bits per character	8 data bits
Parity	None
Stop Bit	2
Flow Control	None

5. MECHANICAL SPECIFICATIONS

Size: 3.00" x 2.94" x 1.42"
Weight: 4.8 oz
Mounting: Four #6-32 screws, 2.42" x 2.45"
Plate: Aluminum, Hard Anodized

Dimensions



6. PIN ASSIGNMENTS

A 12-pin pluggable terminal strip connector P1 provides power and the step and direction control functions for the module. All of these signals are optically isolated. Open-collector drives are required to provide pulses for Step, levels for Direction, and Disable. The common +ve supply can be +ve 5 to 30 VDC with respect to the signal input; however if the supply is greater than 5 VDC then a resistor must be inserted in series with each signal line to limit the current to 10 mA.

P1 Configuration	
Pin No	**Function**
1	Common +ve External
2	Step (in)
3	Direction (in)
4	+5 VDC Internal
5	Disable (in)
6	Motor A+ (out)
7	Motor A- (out)
8	Motor B+ (out)
9	Motor B- (out)
10	Fault (out)
11	Power Ground
12	Power Positive

P1 Connector – Pin 1 Location

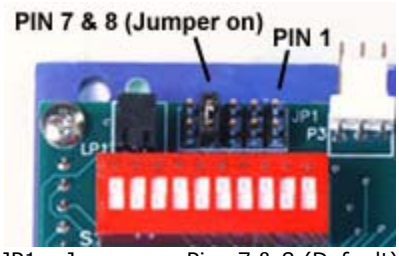
CAUTION: Connecting Motor phases (A, A Bar, B, B Bar) to the incorrect location while the R325 is powered will cause the board to burn. Be sure to insert motor phases into Pins 6 through 9, in the order of A, A Bar, B, and B Bar. It is recommended that power is connected last, so that all connections can be checked before power up.

A separate three pin connector P3 is provided for the RS485 bus interface

P3 Configuration	
Pin No	**Function**
1	A Input (+ve)
2	Ground
3	B Input (-ve)

Mating Connectors

P1	Phoenix Contact	1803675
P2	Amp	640441-5
P3	Amp	640441-3



JP1 – Jumper on Pins 7 & 8 (Default)

7. CONNECTION SPECIFICATIONS

To begin using the R325IE, first determine how you will operate the unit: Simple Controller/Driver or Driver Only. **When using the Controller/Driver, insure that the jumper is located on Pin 7 & 8 on JP1 and that switches 8, 9, and 10 are in the OFF position**, setup must be made with an RS485 connection and communication can take place using Windows HyperTerminal. When using the Driver Only portion of the R325IE, first remove the jumper located on JP1, use the dip switches for step resolution and current settings.

Using the R325IE as a Driver Unit Only

If using the R325IE as a Driver only, **be sure to connect the power supply last.**

Pin1: Connect Pin 1 to Pin 4 to use the internal +5 VDC. By using the internal +5 VDC the I/O's will no longer be optically isolated. If optical isolation is still desired, use a separate +5VDC supply and connect the POSITIVE end of the supply to Pin 1. The NEGATIVE end will connect with the NEGATIVE end of your pulse generator.

Pin 2: Use a pulse generator or function generator to receive pulses into the R325IE. Connect the POSTIVE end of the pulse generator to Pin 2. The NEGATIVE end will be connected to the NEGATIVE end of the +5 VDC supply if using a separate power source. If using the internal +5 VDC supply, connect the NEGATIVE end of the pulse generator to Power GROUND.

Pin 3: To switch the direction of motor rotation, connect Pin 3 with Pin 11, Power Ground. An open or closed connection to Power Ground will change the direction.

Pin 4: This is the internal +5 VDC. Use this for testing purposes or if optical isolation of the I/O's is not desired. It can output a max of 50 mAmps.

Pin 5: To enable the drive leave this Pin open, disable the drive connect Pin 5 with Pin 11 (Power Ground). An open or closed connection to Power Ground will enable and disable the drive, respectively.

Pin 6: Phase A Motor Connection

Pin 7: Phase $\overline{A}$ Motor Connection

Pin 8: Phase B Motor Connection

Pin 9: Phase $\overline{B}$ Motor Connection

CAUTION: Connecting Motor phases (A, A Bar, B, B Bar) to the incorrect location while the R325IE is powered will cause the board to burn. Be sure to insert motor phases into Pins 6 through 9, in the order of A, A Bar, B, and B Bar. It is recommended that power is connected last, so that all connections can be checked before power up.

Pin 10: The Fault Output does nothing in driver only mode. Sits high.

Pin 11: Connect the NEGATIVE of the Power Supply to this terminal.

Pin 12: Connect the POSITIVE of the Power Supply to this terminal. (+15 to 48VDC)

Connecting the Power

The R325IE requires a supply voltage between 15-48 VDC. First, connect the positive end of the power supply to positive terminal (Pin 12), and then connect the negative of the power supply to the Ground (Pin 11) on the R325IE.

WARNING! Be careful not to reverse the polarity from the power supply to the driver. Reversing the connection will destroy your driver and void the warranty.

HyperTerminal Configuration

Configure HyperTerminal to properly communicate with the R325IE.

Please follow these steps to properly set up HyperTerminal:

1. Open a terminal from your PC by following these steps: Start Menu → Programs → Accessories → Communications → HyperTerminal
2. Assign a name for your New Connection, "Click Ok"
3. Under "Connect using", select the COM connection that corresponds to your PC serial port (i.e. COM 1, COM 2, etc.) then click "OK"
4. Set your Port Settings to:
   Bits per second: 57600
   Data bits: 8
   Parity: None
   Stop bits: 2
   Flow control: None
   Click "OK"
5. Turn on local echo by going to: File → Properties → Settings tab → ASCII Setup: Check the boxes for "Send line ends with line feeds" and "Echo Typed Characters Locally." These options will be useful when typing commands in HyperTerminal. Click 'OK", Click "OK"
6. HyperTerminal is ready to send commands

The line turnaround from transmit to receive must be less than one character interval (191 µS).

The command syntax is as follows:

#<Board Address><Command><Value><cr><lf>

The reply syntax is:

**<Board Address><Command> <Value><cr><lf>*

Note: Not all commands will return a value.

Example
Setting the Run Current (RI) to 1500mA (1.5A)

```
#ARI1500   //Sent Command
*ARI1500   //Received Reply
```

Setting the Current

There are two current settings on the R325IE.

1. Run Current (RI) – The peak current that the motor will be run at while in motion.
   NOTE: Current of 2.7 Amp and above REQUIRES an additional heatsink, make sure the temperature of the bracket does not exceed 45° C.

2. Hold Current (HI) – The current that the motor will receive when idle.

*The default board address of 'A' is used in all examples, please see "MA" command for more detail on addresses.

Examples:
To set Run Current to 2000mA (2.0A): `#ARI2000`
To set Hold Current to 300mA (0.3A): `#AHI300`

Setting Step Resolution

The R325IE is capable of full stepping or 2, 4, 8, 16, 32, 64, 128, and 256 microstepping.

Example:
To set Step Resolution to 4x microstepping: #ASR4

Saving the Configuration

In order to have these settings retained upon a power cycle, the data must be saved. The command to store these settings is "SD" (Save Data).

Example:
To save settings: #ASD

Connecting the Motor

WARNING! Make sure the power is OFF when connecting or disconnecting motors from the R325IE. Damage will occur if the power is being supplied.

Please refer to your motor documentation for wiring color code.
Connect the corresponding Phase from the motor to the proper pin on the R325.

Motor Phase	P1 Connector
Phase A	Pin 6
Phase A-	Pin 7
Phase B	Pin 8
Phase B-	Pin 9

Using the R325IE

If using the R325IE in Step/Direction mode, remove the jumper from Pins 7 & 8 on JP1, and proceed to Section 8 – Basic Step and Direction Operation.

If using the R325IE as a simple controller, please insure that there is a jumper on Pins 7 & 8 on JP1, and refer to the Command Tables in Section 9 and more detailed descriptions of the Commands in Section 10.

Configure the R325IE using the DIP Switch

R325IE DIP Switch Settings

In addition to the Jumper on Pin 7 & 8 on JP1, the Switches 8, 9, and 10 must be "OFF" in control mode. If using Step & Direction mode remove the jumper.

Run Current				
Function	**SW1**	**SW2**	**SW3**	**SW4**
0.3A	ON	ON	ON	ON
0.4A	OFF	ON	ON	ON
0.5A	ON	OFF	ON	ON
0.6A	OFF	OFF	ON	ON
0.8A	ON	ON	OFF	ON
1.0A	OFF	ON	OFF	ON
1.2A	ON	OFF	OFF	ON
1.4A	OFF	OFF	OFF	ON
1.6A	ON	ON	ON	OFF
1.8A	OFF	ON	ON	OFF
2.0A	ON	OFF	ON	OFF
2.2A	OFF	OFF	ON	OFF
2.4A	ON	ON	OFF	OFF
2.6A	OFF	ON	OFF	OFF
2.8A	ON	OFF	OFF	OFF
3.0A	OFF	OFF	OFF	OFF

WARNING: Current of 2.7 Amp and above REQUIRES an additional heatsink, make sure the temperature of the bracket does not exceed 45° C

Hold Current (Percent of Run Current)		
Function	**SW5**	**SW6**
0%	ON	ON
33%	OFF	ON
66%	ON	OFF
100%	OFF	OFF

Step Resolution				
Function	**SW7**	**SW8**	**SW9**	**SW10**
Full Step*	OFF	OFF	OFF	OFF
2X	ON	OFF	OFF	OFF
4X	ON	ON	OFF	OFF
8X	ON	OFF	ON	OFF
16X	ON	ON	ON	OFF
32X	ON	OFF	OFF	ON
64X	ON	ON	OFF	ON
128X	ON	OFF	ON	ON
256X	ON	ON	ON	ON

*The power must be turned OFF when switching in and out of Full Step mode.

Notes:

1. Switches 8, 9 , and 10 must be set to 'OFF' to use the R325IE in control mode. This is in addition to installing the jumper on JP1 Pins 7 and 8.
2. Installing a jumper on JP1 Pins 9 and 10 runs the factory test routine

8. BASIC STEP AND DIRECTION OPERATION

The four control signals *Step*, *Direction*, *Disable*, and *Fault Out* are optically isolated, with a common positive connection (usually 5 VDC).

The common positive connection (Pin 1) is typically 5 VDC. Each of the inputs is set to TRUE by supplying a signal level 5V below the common positive connection powering the optical isolators. The input is set FALSE by putting the signal within 0.5 VDC below the common positive value.

For test purposes, and some applications where input isolation is not required, the internal 5 VDC supply at Pin 4 of the I/O connector can be used as the common positive connection, by linking pins 1 and 4 on the connector.

If this is done then each input is set TRUE by bringing the voltage level at the input equal to, or more negative than the Power Supply negative connection at Pin 11.

With this arrangement *Direction*, *Disable*, and *Fault Out* control can be effected by simple switch closure between the input and the power negative connection at Pin 11.

If the *Step* input is obtained from a Function Generator, then careful adjustment of the Offset control is needed to ensure that the negative level of the input signal is equal to, or more negative than, the power negative connection at Pin 11.

The minimum duration of the active (negative) *Step* input signal level is 400 nanoseconds and also this is the minimum for the inactive (positive) level. This limits the maximum usable step rate to 2.5 MHz.

The optimum operating arrangement (minimum power usage) is for a constant width negative going pulse of 400 nanoseconds with the pulse interval varying with pulse rate. For test purposes, setting the Function Generator duty cycle to 50%, and just varying frequency is satisfactory.

Using the R325 with more than 5V

You can choose to supply the optos with the R325's internal 5V supply by jumping pins 1 to 4. But if you choose to use more than 5V, for example, a 24V supply and the step pulse train is also a 0 to 24V low-high signal, please use the following recommended resistor to limit the current to 10 mAmps. Note: no resistor will be needed on the actual opto supply line, pin 1.

Step & Direction lines have a 470 ohm internal resistor

Voltage:	5V	10V	15V	24V
Ohms needed:	0	500	1000	2000
Wattage rating:	0	¼ watt	¼ watt	¼ watt

Disable line has a 1k ohm internal resistor

Voltage:	5V	10V	15V	24V
Ohms needed:	0	1000	2000	3800
Wattage rating:	0	1/8 watt	1/8 watt	¼ watt

9. COMMAND TABLES

To begin using the R325IE in command mode**, insure that the jumper is located on Pin 7 & 8 of JP1 and that switches 8, 9, and 10 are in the OFF position**, setup must be made with an RS485 connection and communication can take place using Windows HyperTerminal. When using the Driver Only portion of the R325IE, first remove the jumper located on JP1, use the dip switches for step resolution and current settings.

Basic Configuration Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Load Defaults	N	LD	None	-	-	-
Save Data	N	SD	None	-	-	-
Module Address	Q/N	MA	Numeric	65 (A)	90 (Z)	65 (A)

Axis Configuration Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Acceleration	Q/N	AC	Numeric	1	250	10
Hold Current	Q/N	HI	Numeric	0	3000	300
Hold Timeout	Q/N	HT	Numeric	100	5000	5000
Min. Velocity	Q/N	MV	Numeric	256	15,000	256
Percent Fast Decay	Q/N	PF	Numeric	0	3	2
Run Current	Q/N	RI	Binary	300	3000	1000
Read Switches	Q	RS	Numeric	0	15	-
Step Resolution	Q/N	SR	Numeric	1	256	16
Start Velocity	Q/N	SV	Numeric	256	15,000	1,000
Velocity Limit	Q/N	VL	Numeric	256	15,000	15,000
Zero Position	N	ZP	None	-	-	-

General Operation Commands

Function	Query/New	Code	Value	Minimum	Maximum	Default
Absolute Position	N	AP	Numeric	-2147483646	2147483647	-
Current Position	Q/N	CP	Numeric	-2147483646	2147483647	-
Current Velocity	Q	CV	Numeric	0	50,000	-
Direction Velocity*	N	DV	Numeric	-50,000	50,000	-
Firmware Rev.	Q	FR	Numeric	-	-	-
Home Axis	N	HA	Numeric	0	1	-
Move Status	Q	MS	Numeric	0	2	-
Position Move	N	PM	Numeric	-2000000000	2000000000	-
Step Back	N	SB	None	-	-	-
Step Forward	N	SF	None	-	-	-
Stop Motion	N	SM	None	-	-	-
Velocity Move *	Q	VM	Numeric	-50,000	50,000	-

* Velocity Moves in the range –249 to 249 are not legal except zero

'E' Version Commands

Function	Query / New	Code	Value	Minimum	Maximum	Default
Current Encoder	Q	CE	Numeric	0	16777215	
Error Action	Q/N	EA	Numeric	0	2	2
Encoder Installed	Q/N	EI	Boolean	0	1	1 (TRUE)
Encoder Lines	Q/N	EL	Numeric	0	16777215	400
Encoder Mode	Q/N	EM	Numeric	1	2	2
Error Permitted	Q/N	EP	Numeric	0	16777215	Enc Cnt
Error Read	Q	ER	Numeric	0	16777215	
Go A		GA				
Go B		GB				
Go C		GC				
Go D		GD				
Go E		GE				
Go F		GF				
Go G		GG				
Go H		GH				
Home Axis		HA	Boolean	0	1	0 = FWD
Motor Fullsteps	Q/N	MF	Numeric	0	16777215	200
Target A	Q/N	TA	Numeric	0	16777215	25
Target B	Q/N	TB	Numeric	0	16777215	50
Target C	Q/N	TC	Numeric	0	16777215	75
Target D	Q/N	TD	Numeric	0	16777215	100
Target E	Q/N	TE	Numeric	0	16777215	125
Target F	Q/N	TF	Numeric	0	16777215	150
Target G	Q/N	TG	Numeric	0	16777215	175
Target H	Q/N	TH	Numeric	0	16777215	200
Zero Position		ZP				

10. COMMANDS

Protocol Syntax

Command Format: #<Address><Command><value><CR><LF>
Example: #ACP1000<CR><LF>
Sets Driver A to the current position of 1000

To query a command use the following format
Query Format: #<Address><Command><CR><LF>
Example: #AAC<CR><LF>
Queries Driver A for the current Acceleration Value

The response would be in the following format
Response Format: *<Address><value>
Example: *AAC10
The Acceleration Value for Driver A is 10

<CR><LF> stand for "Carriage Return" and "Line Feed" respectively. These are NOT characters to be typed in. For direct keyboard users, these values are executed when the "Return" key is pressed. For programmers, a "Carriage Return" and "Line Feed" (also known as a "New Line") command needs to be executed after each command.

<table>
<tr><th>Command
(Case Sensitive)</th><th>Operand</th><th>Example</th><th>Description</th></tr>
<tr><td colspan="4">HOMING & POSITIONING</td></tr>
<tr><td>HA</td><td>0 = Forward
1 = Reverse</td><td>#AHA1

Motor turns in the reverse direction</td><td>Home Axis - Command Only
- Causes the motor to move at the preset Start Velocity (SV) in the direction set by the command value. Motion stops when the index input of a device on the input pin goes TRUE then stops and sets Absolute Position and Current Encoder to zero. Motion can also stop by the entry of a Stop Motion (SM) command.
- Forward is defined as the direction the motor turns when the 'Direction' input (P1-3) is set TRUE, or there is no connection to this input.

<table><tr><th colspan="2">P2 Configuration</th></tr><tr><th>Pin No</th><th>Function</th></tr><tr><td>1</td><td>GND</td></tr><tr><td>2</td><td>Index</td></tr><tr><td>3</td><td>-</td></tr><tr><td>4</td><td>+5 V</td></tr><tr><td>5</td><td>-</td></tr></table></td></tr>
<tr><td>CP</td><td>+/−
2,147,483,646</td><td>#ACP1000
Sets the current position to be 1000

#ACP
Returns the current position of the motor</td><td>Current Position - Command or Query.
- Returns the absolute position of the axis if no value is passed. Valid after power cycles if a Save Data Command is issued before power down. Can be used to set current position value.
The units are steps at the current step resolution (value becomes invalid with step resolution changes). The absolute position scale is set to zero by the Zero Position command (ZP) or the execution of a Home Axis (HA) command.</td></tr>
<tr><td>ZP</td><td>-</td><td>#AZP</td><td>Zero Position - Command Only
- Sets the Current Position and the Encoder Position to zero

Note: This command functions differently between R325I and R325IE</td></tr>
<tr><td colspan="4">VELOCITY & ACCELERATION</td></tr>
<tr><td>AC</td><td>1 - 250</td><td>#AAC1

Sets Acceleration to 1000 PPS^2</td><td>Acceleration - Command or Query
Default = 10

Used to shape the acceleration and deceleration ramps of position moves, and the rate of velocity change for velocity moves. Does not affect any of the basic step and direction move operations. Acceleration Factor * 1000 Pulses per Second</td></tr>
<tr><td>AP</td><td>+/−
2,147,483,646</td><td>#AAP1000

Moves to the 1000th position.</td><td>Absolute Position - Command Only
- Used to make an absolute position move (in step resolution units).</td></tr>
<tr><td>CV</td><td>+/- 50,000</td><td>#ACV</td><td>Current Velocity - Query Only
- Only valid when a Position Move (PM) or Velocity Move (VM) is in progress. Otherwise returns zero.</td></tr>
<tr><td>DV

(only on firmware ver.# 2.09 or later)</td><td>250 to 50,000, -250 to -50,000 or 0</td><td>#ADV1000
#ADV-1000

Goes from + to – direction, ramping up & down</td><td>Direction Velocity – Command Only
-This command is the exact same as Velocity Move (VM) with the addition of being able to ramp up and down when making moves from Positive to Negative. In the given example, it will rotate at 1000 pps. When issued #ADV-1000, it will ramp down to 0 then back up to 1000 pps but rotating in the opposite direction.
Note: No value is returned.</td></tr>
<tr><td>MS</td><td>0 -2</td><td>#AMS</td><td>Move Status - Query Only
- Reads Motion Status. Returns 0 for No Motion, 1 for Position Move, and 2 for Velocity Move.</td></tr>
<tr><td>MV</td><td>256 - 50,000</td><td>#AMV500

Sets minimum velocity to 500 SPS</td><td>Minimum Velocity - Command or Query
Default = 256
- Reads or sets the minimum velocity for both Position and Velocity command moves. The units are steps (at the current Step Resolution) per second.</td></tr>
</table>

Command (Case Sensitive)	Operand	Example	Description
VELOCITY & ACCELERATION (cont.)			
PM	+/- 2,000,000,000	*#APM1000* *Makes a 1000 step move from the current position*	**Position Move** - Command Only - Causes a 'Relative Motion' Position Move, using an approximately trapezoidal profile. The initial velocity is defined by 'Start Velocity' (SV), the profile ramp is defined by 'Acceleration' (AC), and the 'Constant Velocity' step rate by 'Velocity Limit' (VL). 'Minimum Velocity' (MV) is used to ensure that the deceleration ramp does not set velocity to zero before the target position is reached. - It should be remembered that, while the 'Position Move' value defines the number of steps to be made from the current position, the value returned by 'Current Position' (CP) both before and after a 'Position Move' are on an 'Absolute' step count scale. - CP readings can be used to determine PM values required to reach any given position on the 'Absolute' step count scale. *Note: This command does not return a value.*
SB	-	*#ASB* *Moves one step back*	**Step Back** - Command Only - Makes a single step move at the current step resolution - Forward is defined as the direction the motor moves with the 'Direction' input in the FALSE state or with no connection. Backwards is thus the direction the motor moves when the 'Direction' input is in the energized or TRUE state.
SF	-	*#ASF* Moves one step forward	**Step Forward -** Command Only - Makes a single step move at the current step resolution - Forward is defined as the direction the motor moves with the 'Direction' input in the FALSE state, or with no connection. Backwards is thus the direction the motor moves when the 'Direction' input is in the energized or TRUE state.
SM	-	*#ASM* *Stops any Position or Velocity move in progress*	**Stop Motion** Command Only - This command can be used to affect an end to any Position Move or Velocity Move in progress. It has no effect on motion produced by the Step and Direction inputs.
SV	256 - 15000	*#ASV500* *Start velocity set to 500 PPS*	**Start Velocity** - Command or Query Default = 1000 - Reads or sets the velocity used for the first step in a position move in steps/sec. Value based on motor performance.
VL	256 - 15000	*#AVL5000* *Sets the velocity limit to 5000 steps/sec*	**Velocity Limit** - Command or Query Default = 15000 - Reads or sets the velocity used for Velocity Moves and the constant velocity portion of a Position Move.
VM	250 - 50,000, -250 - -50,000 or 0	*#AVM1000* *Starts a velocity move of 1000 steps per second*	**Velocity Move** - *Command Only* - The sign of the value determines the direction (positive for forward and negative for backward) in which the velocity move is made. The value sets the step rate in steps per second at the current step resolution. Velocity cannot exceed Velocity Limit. - The move begins at the set 'Minimum Velocity' (MV) with the speed ramping to the command velocity at the rate set by 'Acceleration' (AC). - Changes to new velocity values from new VM commands, will also occur at the rate set by 'Acceleration' (AC). *Note: No value is returned. Zero velocity makes an abrupt stop*

Command (Case Sensitive)	Operand	Example	Description
SETTING CURRENT			
HI	0-3000	*#AHI300* *Sets the Hold Current to 300mA (0.3A)*	**Hold Current** - Command or Query - 0 to 3000 Default = 300 - Reads or sets the motor Holding Current in 100 milliamps increments. The value does not round.
RI	300 - 3000	*#ARI1000* *Sets the run current to 1000 mA (1.0 Amp)*	**Run Current** - Command or Query Default = 1000 - Sets the motor Phase Current for any form of motion in milliamps. 300 = 300mA (0.3 Amp) 2500 = 2500mA (2.5 Amp) The last two numbers of the value are not read. 350 = 300mA, 2499 = 2400mA - The set 'Run Current' is maintained for a time set by 'Hold Timeout' (HT) before dropping to the current set by 'Hold Current' (HI) ***NOTE: Current of 2.7 Amp and above REQUIRES an additional heatsink, make sure the temperature of the bracket does not exceed 45° C***
HT	100 -5000	*#AHT100* *Sets the Hold Timeout to 100 mS*	**Hold Timeout** - Command or Query Default = 5000 - Reads or sets the time interval in milliseconds after any motor movement, before the motor current is changed from Run Current to Hold Current.
STORAGE & RECALL			
LD	-	*#ALD* *Loads all the default values*	**Load Defaults** - Command Only - Loads all of the unit Default parameter values. A Save Data (SD) command must be issued to have these values retained during a power cycle. Default values are: Module Address 65 (A) Acceleration 50 Absolute Position 0 Percent Fast Decay 2 Hold Current 300 (0.3A) Hold Timeout 5000 Minimum Velocity 256 Run Current 1000 (1.0A) Step Resolution 16 Start Velocity 1000 Velocity Limit 15000
SD	-	*#ASD* *Saves data*	**Save Data** - Command Only - This command causes a set of parameter values to be written to non-volatile memory. On power up the last set of values written are set to be the parameter initial values. -The parameters whose values are thus saved are: My Address Absolute Position Velocity Limit Minimum Velocity Start Velocity Acceleration Hold Timeout Step Resolution Run Current Hold Current Percent Fast Decay

Command (Case Sensitive)	Operand	Example	Description
MISC			
PF	0, 1, 2, 3	*#ACD1* *Sets Mixed Mode damping to 15%*	**Percent Fast Decay** - Command or Query Default = 2 - Allows the Damping Mode of the driver IC to be set. 0 = Fast Decay 1 = Mixed Mode 15% 2 = Mixed Mode 48% 3 = 100% The optimum setting will vary with motor inductance and step rate; however the default 'Mixed Mode' setting will work well with almost all motors.
MICROSTEPPING			
SR	1, 2, 4, 8, 16, 32, 64, 128, 256	*#ASR4* *Sets the step resolution to 4x*	**Step Resolution** - Command or Query Default = 16 - Reads or sets the current step resolution Allowed values are: 256 for 256x 128 for 128x 64 for 64x 32 for 32x 16 for 16x 8 for 8x 4 for 4x 2 for 2x 1 for 1x
QUERY COMMANDS			
FR	-	*#AFR*	**Firmware Revision** - Query Only - Returns 3 digit part code followed by 3 digit firmware revision value. Reply *AFR325100 //R325 firmware revision 1.00
MA	65 - 90	*#AMA88* *Sets the unit address to 88 ('X')*	**My Address** - Command or Query Default = 65 - Reads or sets the unit address. The value read or entered is the decimal value of the ASCII character designated as the unit address. (65 = 'A' and 90 = 'Z') The change to a new address is immediate, in that the command response will use the new address
RS	-	*#ARS* *Reads the switch inputs*	**Read Switches** - Query Only - Reads the TRUE (1) or FALSE (0) state of the three optically coupled inputs, combined into a single three-bit value. This command is used to check the correct operation of this interface. - The value order of the inputs is 'Direction', 'Disable', and 'Step'; in descending order. 'Direction' has the value 4 (100) 'Disable' has the value 2 (010) 'Step' has the value 1 (001)
TI	-	*#ATI* *Reads the switch inputs*	**Test Inputs -** Query Only Step, Direction, and Disable all return a value in decimal form. The value order of the inputs is: 'Direction', 'Disable', and 'Step'; in descending order. 'Direction' has the value 4 (100) 'Disable' has the value 2 (010) 'Step' has the value 1 (001) Reply *ATI3 // 3 = '011'

Command (Case Sensitive)	Operand	Example	Description
ENCODER VERSION COMMANDS			
CE	+/- 16777215 (Motor Position in Encoder counts)	*#ACE* **ACE12345*	**Current Encoder** – Query Only - Returns a 16-bit signed value, corresponding to the current motor position encoder count. (See Encoder Mode)
EA	0, 1, 2	*#AAEA2* *Sets Error Action to Correct Mode*	**Error Action** – Command or Query Default = 2 - Reads or sets a value that determines the action to be taken when an encoder error is found 0 – The error is reported via the optocoupled output 1 – The error is reported and the motor is stopped 2 – The error is reported and the correction move is made
EI	0, 1	*#AEI1* *Encoder Installed True*	**Encoder Installed** – Command or Query Default = 1 - Read or set TRUE (1) or FALSE (0)
EL	0 - 16777215	*#AEL400* *Sets the encoder line count to 400*	**Encoder Lines** – Command or Query Default = 400 - Encoder lines per motor revolution - Reads or sets the encoder line count. This is used in conjunction with Encoder Mode to calculated motor positions.
EM	1, 2	*#AEM2* *Sets the Encoder Mode to 2*	**Encoder Mode** – Command or Query Default = 2 - Reads or sets the operating mode of the Encoder Interface IC. A value of 1 returns one Encoder Count per Encoder Line. A value of 2 returns 2 Encoder Counts per Encoder Line. Only 1 and 2 are valid.
EP	0 – 16777215	*#AEP10*	**Error Permitted**- Command or Query - Reads or sets the maximum error allowed before Error Action is taken. Depending on the system configuration, the value is given in either Encoder Counts or Steps at the current Step Resolution. - If the product of Encoder Lines and Encoder Mode is larger than the product of Motor Steps and Step Resolution, then the value is in Encoder Counts. Otherwise it is in Steps. Note: The minimum value is the number of the finer resolution Encoder Counts or Steps required to make up one unit of the coarser resolution.
ER	0 - 16777215	*#AER* **AER5*	**Error Read** – Query Only - Returns the current Encoder Error value. If the product of Encoder Lines and Encoder mode is larger than the product of Motor Steps and Step Resolution, then the error is in Encoder Counts. Otherwise it is in Steps.
GA	-	*#AGA*	**Go Target A** – Command Only **This applies to "Go Target B, C, D, E, F, G, H"** Initiates position move to the corresponding Target Position set by TA.
MF	-	*#AMF200* *Sets Motor Fullsteps to 200*	**Motor Fullsteps (per revolution)** – Command or Query Default = 200 Reads or sets the number of Fullsteps per motor revolution, i.e. A 1.8° motor will have a Fullstep count of 200.
TA	-	*#ATA100*	**Target A** – Command or Query **This applies to "Target B, C, D, E, F, G, H"** - Reads or sets the value of a preset Target Position in Fullstep units as an absolute value Initiates position move to the corresponding Target Position set by TC.

11. RS485 Communication

1. The Interface

The EIA specification RS485 defines an integrated circuit that is to be used to connect up to 32 nodes to a two-wire party line bus that does not exceed 4,000 ft. in length, and for use with data rates up to 10M Baud.

The two-wire bus must be terminated at one-end for short wire runs and at both ends if the runs exceed 20 ft. One of the two wires must be biased positive with respect to the other by approximately 700 millivolts.

A single 5VDC supply can be used to power the interface IC, and this same supply can be used to satisfy the bias and termination requirements. A 681 ohm 1% resistor is connected between the +5VDC supply and the positive line. A second 681 ohm 1% resistor is connected between ground and the negative line, and a 220 ohm 1% resistor is connected across the two lines. The transceiver A terminal is connected to the negative line and the B terminals to the positive line.

For wire runs over 20 ft, twisted pair cable with a characteristic impedance of approximately 100 to 200 ohms, and the far end of the run should be terminated by a 150 ohm resistor across the line pair. For runs under 20ft almost any wire can be used.

2. The Protocol

One node on the bus is designated 'Master' and all other nodes on the bus 'Slaves'. The Master only initiates communication, and does so by sending a message that includes the address of a specific Slave. All Slaves read the message, but only the addressed Slave replies.

The outgoing message from the Master is 'framed' by always starting the message with the '#' character (0x23) and ending with the linefeed character (0x0A). The reply from the Slave is framed by always starting with the '*' character (0x2A) and ending with the linefeed character (0x0A).

The Slave address is the first character after the '#' in the outgoing message, and the first character after the '*' in the reply. For ease of use RMS Technologies restricts the range of address characters to the range of capital letters 'A' to 'Z', with 'A' being the default.

Again for ease of use RMS Technologies restricts the other characters in the message to ASCII printable characters. This enables the default Windows terminal emulation program HyperTerminal to be used for configuring and testing modules. However this restriction and the restricted address range are not an official part of the protocol. Any of the 8 bit character values other than the framing characters can be used for the address and as any other part of the message.

3. Messages

Messages should be transmitted as a continuous character stream with less than a half character time between characters.

Messages are classified as either 'Commands' or 'Queries'. Commands instruct the designated Slave to do something. Queries request the designated Slave to provide information.
Apart from the leading '#' being replaced by a '*', the Slaves response to a Command should be an exact copy of the command message. In the case of a Query the query message is also echoed but the value or other requested information is added into the reply.

A one character time interval has to be allowed between outgoing and incoming messages, to allow for line turn-around (Switching between Transmit and Receive). At 57,600 baud, one character with 11 bits (one start, eight data, and two stop bits) transmits in 191 µS.

4. Validation

Commands are validated by comparing the content of the reply with the content of the command message on a character by character basis.

Queries are partially validated in a similar manner but the information added by the Slave is only subjected to credibility tests. When the information returned is deemed critical, repeating the Query and comparing results can further validate communications.

5. S Message Format

A two-character command/query designator follows the single address character. Depending on the nature of the command, the command designator may be followed by a numeric ASCII character string. No separator characters are used, but a carriage return character (0x0D) is inserted before the termination character in both the outgoing message and the reply.

6. Data Format

Data is transmitted at 57,600 Baud, with eight data bits, no parity, and two stop bits.

7. Recommended Interface Device

The RMS Technologies USB485 Converter Card converts the RS485 connection to a standard USB connection (1.1 and 2.0 compatible).

8. HyperTerminal Operation

In addition to setting the data format to match that specified in section 6, two settings must be made in the ASCII setup section. Check ‘Send Line Ends with Line Feeds’ and ‘Echo Typed Characters Locally’.

When typing by hand line turn-around will occur between characters. This is normally not a problem, but if you slowly increase the character transmission rate you will find errors occurring, until you reach a rate where the line is held in the transmit mode for the whole of the message. Using HyperTerminal’s file transfer system to send messages is not recommended.

9. Reading Reply Messages

The message read function on the RS232 side of the interface, must make provision for discarding any characters read that proceed the ‘*’ character. Line turn-around can commonly generate false characters.

The function should have a time-out associated with waiting for a reply to allow for a non-operational Slave node. The actual time required is system dependent, but 20mS is a commonly used value.

12. Troubleshooting

R325IE is not functioning correctly

Try putting the R325 into TEST mode by placing a jumper on Pins 9 & 10 of JP2. The motor should twitch back and forth slightly if the R325IE is functioning properly.

R325IE not moving the motor (Step/Dir)

Verify that the 5V is being supplied to Pin 1.

The R325IE is causing the motor to vibrate and jitter back and forth

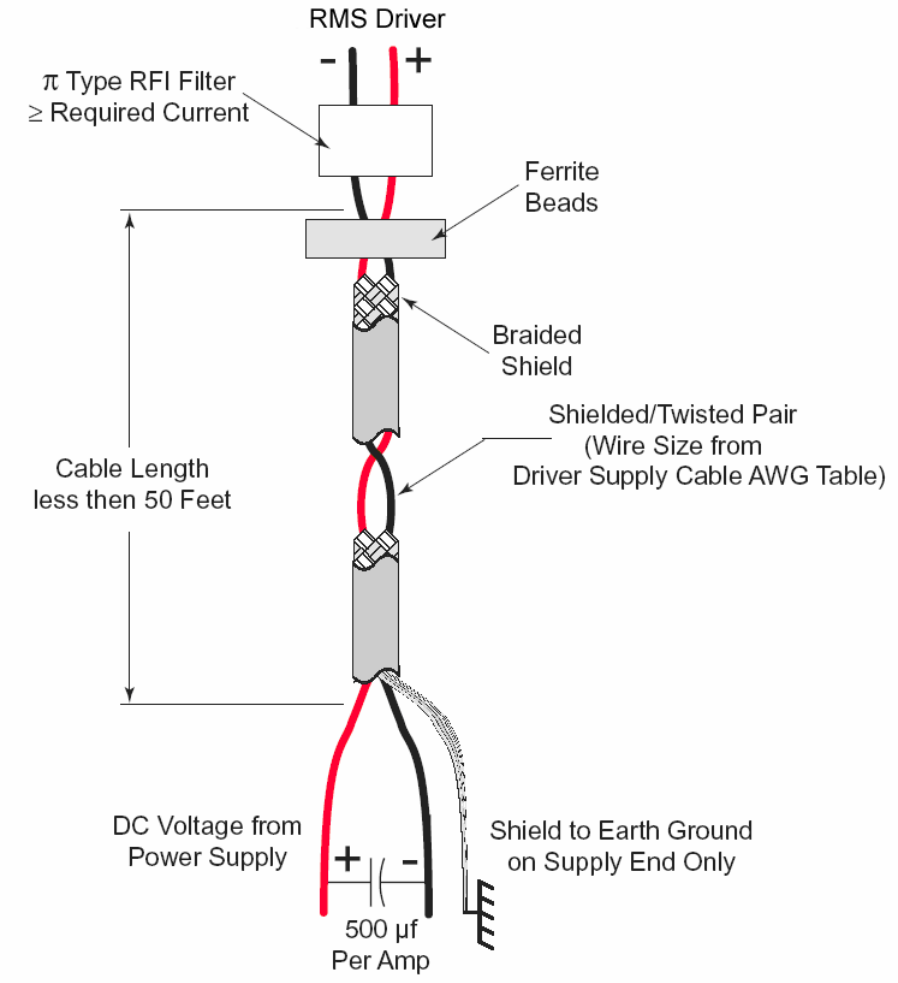
Are the Motor phases switched? Be sure to check that motor wires are connected to Pins 6 through 9 of P1, in the order of A, A Bar, B, B Bar. To check which wires belong to one phase, take a Meter to measure resistance between any two wires. If there is a finite value between two of them, insert the wires into pins 6 and 7, OR pins 8 and 9. Insert the remaining two wires accordingly.

13. Appendix A: Recommended Cables

Recommended Cable Configurations: DC Supply to Driver

Cable length, wire gauge and power conditioning devices play a major role in the performance of your RMS Technologies Driver and Motor.

NOTE: The length of the DC power supply cable to the Driver should not exceed 50 feet.



Example A demonstrates the recommended cable configuration for DC power supply cabling under 50 feet long. If cabling of 50 feet or longer is required, the additional length may be gained by adding an AC power supply cable.

Correct AWG wire size is determined by the current requirement plus cable length. Please see the Driver Supply Cable AWG Table in this Appendix.

NOTE: These recommendations will provide optimal protection against EMI and RFI. The actual cable type, wire gauge, shield type and filtering devices used are dependent on the customer's application and system.

Driver Supply Cable AWG Table					
1 Amp (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	20	18	18	16
2 Amp (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	18	16	14	14
3 Amp (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	18	16	14	12	12
* Use the alternative methods illustrated in Examples B and C when the cable length is ≥ 50 feet. Also, use the same current rating when the alternate AC power is used					

Driver Supply Cable Wire Size

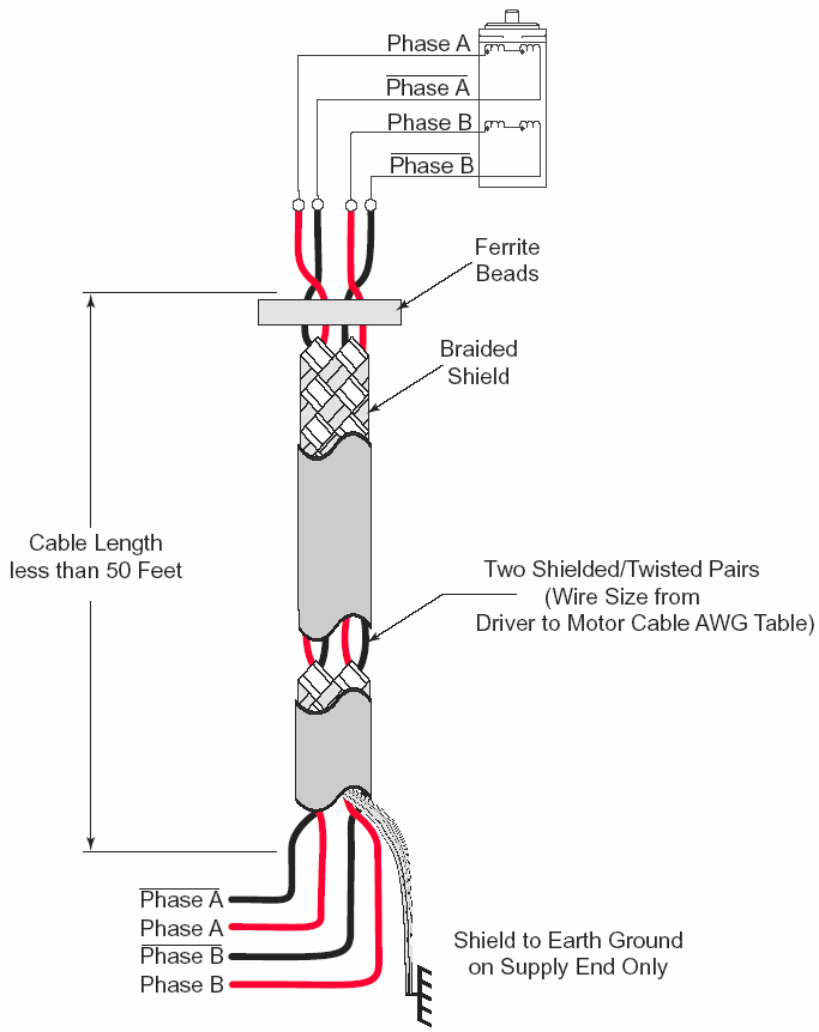
NOTE: Always use Shielded/Twisted Pairs for the Driver DC Supply Cable, the AC Supply Cable and the Driver to Motor Cable.

Recommended Cable Configurations: Driver to Motor

Cable length, wire gauge and power conditioning devices play a major role in the performance of your Driver and Motor.

NOTE: The length of the DC power supply cable between the Driver and the Motor should not exceed 50 feet.

Example A demonstrates the recommended cable configuration for the Driver to Motor cabling under 50 Feet long.



If cabling of 50 feet or longer is required, the additional length can be gained by adding Common Mode Line Filters (2x)

*L ≈ 0.5 MH
* 0.5 MH is a typical starting point for the Common Mode Line Filters. By increasing or decreasing the value of L you can set the drain current to a minimum to meet your requirements.

Driver to Motor Cable AWG Table											
	1 Amp (Peak)						5 Amp (Peak)				
Length (Feet)	10	25	50	75	100	Length (Feet)	10	25	50	75	100
Minimum AWG	20	20	18	18	16	Minimum AWG	16	16	14	12	12
	2 Amp (Peak)						6 Amp (Peak)				
Length (Feet)	10	25	50	75	100	Length (Feet)	10	25	50	75	100
Minimum AWG	20	18	16	14	14	Minimum AWG	14	14	14	12	12
	3 Amp (Peak)						7 Amp (Peak)				
Length (Feet)	10	25	50	75	100	Length (Feet)	10	25	50	75	100
Minimum AWG	18	16	14	12	12	Minimum AWG	12	12	12	12	12
	4 Amp (Peak)										
Length (Feet)	10	25	50	75	100						
Minimum AWG	18	16	14	12	12						

Driver to Motor Supply Cable Wire Size

NOTE: These recommendations will provide optimal protection against EMI and RFI. The actual cable type, wire gauge, shield type and filtering devices used are dependent on the customer's application and system.

NOTE: Always use Shielded/Twisted Pairs for the Driver DC Supply Cable, the AC Supply Cable and the Driver to Motor Cable.

14. Appendix B: PF Value

For applications requiring ultimate smoothness of motion and extreme accuracy, the R325 driver can be programmed via RS485 to change the Percent Fast Decay rate, or, the PF value.

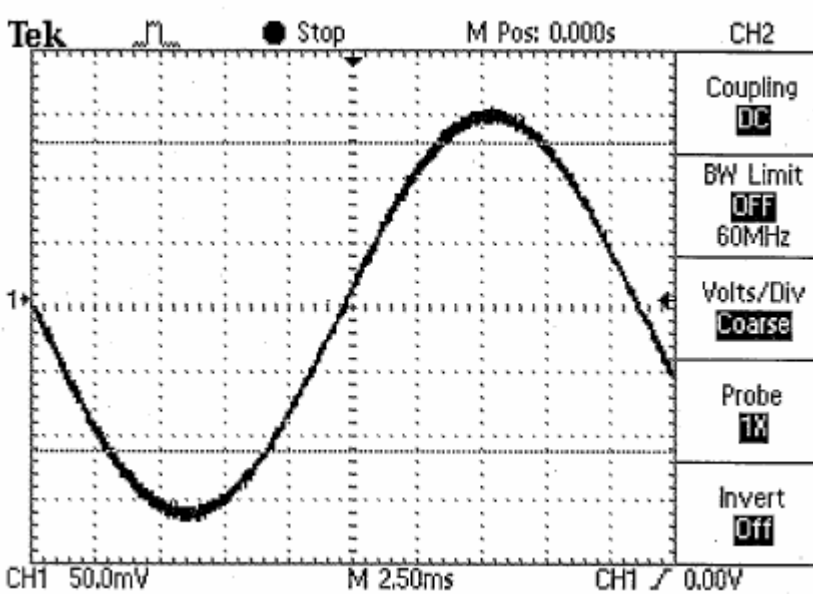
The Percent Fast Decay default is 2, or a mixed mode of 48%.

Mixed mode is a damping technique done to the driver IC. The following values indicate the choices for Percent Fast Decay:

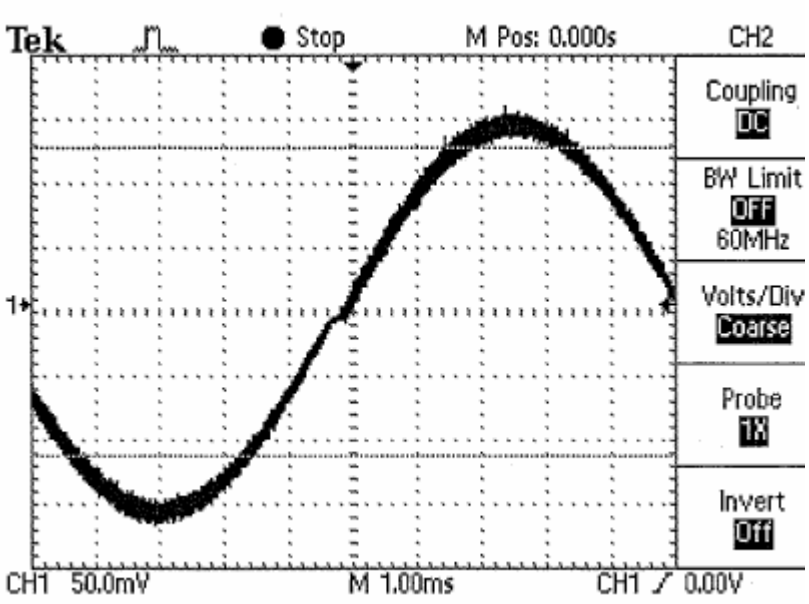
PF Values (0 through 4):
0 = Fast Decay
1 = Mixed Mode 15%
2 = Mixed Mode 48%
3 = 100%

Generally speaking, applications that run at slow speeds are recommended to use a PF value of 1 or less. Fast speeds should use a PF value of 2 or more. Since the best PF value is dependent on the motor winding, loads, power supply voltage, and other factors, it is best to use an oscilloscope and a current probe device to view the current waveform and try different PF values. The following examples show good and bad waveforms when choosing different PF values.

- PF value 1
- Slow speeds
- Good waveform



- PF value 2
- Slow speeds
- Bad waveform



- PF value 1
- Fast speeds
- Bad waveform